CO_2 CLEANING

Efficient performance for research applications

Carbon dioxide (CO_2) is a colorless gas formed as a by-product of industrial processes, such as petroleum refining and brewing. In its solid phase, it is referred to as “snow” or pellets, depending on its size. Delivered at high velocities, the benign CO_2 cleans surfaces through a combination of dissolution, thermal shock, and momentum transfer. It is environmentally safe and efficient and has been used for industrial applications, such as aerospace and electronics, for about twelve years. Recently, Department of Energy–Hanford successfully used CO_2 to decommission equipment contaminated with transuranics.

Building on these advances, the Pollution Prevention Group and the Lasers and Defense and Nuclear Technologies directorates at Lawrence Livermore National Laboratory (LLNL) funded a pilot study. This study will determine if CO_2 cleaning techniques can remove tritium, hydrocarbon contamination, and laser-shot debris from metal and glass substrates, optics-related hardware, and other laser-related components to be used in the proposed National Ignition Facility (NIF) target chamber.

If CO_2 cleaning is effective, the study must determine if the gaseous CO_2 by-product from these cleaning processes can be emitted safely to the atmosphere without entraining any hazardous or radioactive materials. Because environmental safety and equipment-cleaning procedures will be concurrent NIF design priorities, these studies must take place before the facility is built.

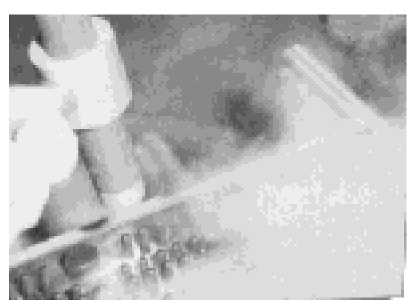
Analytic model

One study team is making a complete analysis of just how solid CO_2 cleaning works. The team is analyzing the effect of contaminant bonding strength and surface and thermal properties as well as the impact of CO_2 pellet size, velocity, uniformity, delivery geometry, stand-off distance, and angle of impingement.

Scientists must conduct 20 or 30 experiments a week at NIF, so the chamber will probably have to be cleaned in only 12 hours. Because the chamber will have more than 3 million square centimeters of interior and over 300,000 square centimeters of optical surfaces, this cleaning must be fast and accurate.

Applications

- *Laser-shot debris from metal and glass substrate*
- *Optics-related hardware*
- *Building and glove-box decontamination*
- *Central, stationary cleaning station*



CO_2 snow cleans sensitive surfaces without abrasion.

Experimental work

Another study team is examining the application and implementation of CO_2 cleaning. This study is jointly funded by the Pollution Prevention Group and Laser Programs. Once sample coupon testing is completed, and various metal and optical lens substrates are understood in relation to tritium and other material decontamination, the team will develop a conceptual cleaning design for the NIF target chamber. The design will integrate robotic manipulation of a CO_2 delivery nozzle with a close-capture, emissions-monitored effluent recovery and filtration system.

Emissions monitoring will be the final test. LLNL must verify that the CO_2, liberated debris, and tritium-contaminated waste from the cleaning process fall within acceptable state and federal emission standards.

If the group successfully engineers the NIF cleaning, it plans to apply the technology to tritium waste cleanup; building and glove-box decontamination; and a central, stationary cleaning station.

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